SASKATCHEWAN WATER CORPORATION

Managing a Vital Resource

Irrigated Alfalfa Production

Irrigation Services
Operations Division
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Introduction

The objective of this publication is to improve yields of irrigated alfalfa in Saskatchewan which means better economic returns for the farmer.

Alfalfa has long been popular because of its hardiness, productivity and high nutritional value. Alfalfa is one of the major crops grown on Saskatchewan's irrigation farms.

Irrigated alfalfa in Saskatchewan came into its own after the "dirty thirties" as a result of the P.F.R.A. designed irrigation projects in the South West. More recently, provincial hay projects such as Chesterfield Flats, Miry Creek and Grainlands have provided much needed irrigation alfalfa along with the South Saskatchewan River between the Alberta border and Lake Diefenbaker. The South Saskatchewan River Irrigation District No. 1 traditionally has about 20% of the project acreage seeded to alfalfa. Irrigated alfalfa is also being grown on projects along the banks of the North Saskatchewan River and throughout the grain belt on smaller individual projects. Irrigated alfalfa is now very popular in Saskatchewan and is expected to become even more popular as the irrigation area expands.

This publication outlines proven production practices and recommendations suited for irrigated alfalfa forage production in Saskatchewan. The publication does not include recommendations for seed or dryland alfalfa production.

Our information sources include farmers with extensive experience in irrigated alfalfa production, researchers in North Dakota, Manitoba, Saskatchewan and Alberta and Saskatchewan Agriculture staff.

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Pre-Planting Considerations

Alfalfa is a perennial crop. Any mistakes made at the time of establishment will affect productivity for the life of the stand.

The decision to plant alfalfa on a field should be made at least a year in advance of planting to ensure a vigorous healthy alfalfa stand. The following should be considered in the pre-planting stage:

1) Weed Control

Perennial weeds should be controlled in annual crops prior to planting alfalfa. Avoid fields with quackgrass, sow thistle, Canada thistle, field bindweed, or similar highly competitive perennials.

2) Rotation

Alfalfa works very well in long term rotations as it interrupts the life cycle of diseases, insects and weeds associated with cereals and oilseeds. In addition alfalfa is a soil building crop with the roots and crowns adding organic matter to the soil when the field is worked down. Some rotational concerns when growing alfalfa are:

— Alfalfa diseases. To reduce the risk of verticillium wilt and other diseases of alfalfa, wait at least three years between breaking an alfalfa stand and replanting alfalfa or planting potatoes, sunflower, or clover.

— Herbicide carryover. To reduce the risks of injury due to herbicide carryover wait at least three years after the application of herbicides such as Tordon 202C, Atrazine and Glean before seeding alfalfa.

3) Varieties

Varieties are selected on the basis of winter hardiness, rate of regrowth, rooting pattern, disease resistance, intended use, irrigation vs dryland and the length of rotation desired.

In areas where irrigation water is not limited grow varieties having rapid regrowth, good winter hardiness and disease resistance.

In areas where irrigation water may be limited or where a producer wishes to maintain the alfalfa stand for a period greater than five years, one of the creeping rooted varieties may be recommended.

The hardier creeping rooted varieties are lower yielding under irrigated conditions and are only recommended on heavy textured gravity irrigated soils in the south west part of the province.

Alfalfa varieties listed in the "Forage Crop Recommendations" pamphlet have undergone extensive testing for yield, winter hardiness and quality, under Saskatchewan conditions, and have proven their suitability for production in this province. Varieties not listed have either been shown to be lower yielding over a period of years or have not been sufficiently tested in Saskatchewan to warrant a recommendation. Any grower planting such varieties would be well advised to limit his planting to 5 or 10 hectares (12 to 25 acres) until that variety has proven its capabilities.

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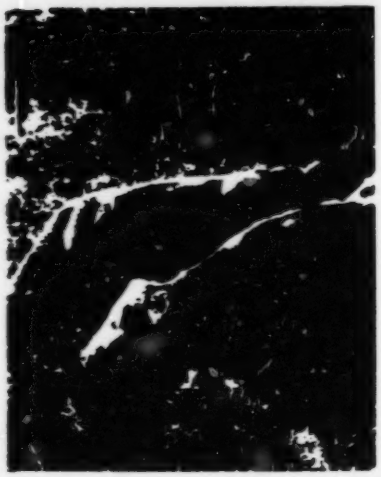
FORAGE CROP RECOMMENDATIONS



Varieties recommended for Saskatchewan are outlined in the annual Forage Crop Recommendations pamphlet available from Saskatchewan Agriculture.

4) Cover Crop vs Direct Seeding

Direct seeding of alfalfa with a recommended preplant incorporated herbicide results in a more uniform, vigorous and weed free stand than is produced where a cover crop is seeded along with the alfalfa. Direct seeded alfalfa should produce a single harvest of 2 to 3 t/ha (.9 to 1.3 T/ac) the first year. In the second year yields will often be higher on direct seeded fields than on fields grown with a full season cover crop.

A cover crop should be used only in situations where spring soil erosion is a problem or where a crop must be established prior to irrigation, e.g. gravity irrigation.

If a cover crop is required there are a number of choices a grower can make which will promote the establishment of a good alfalfa stand. Choose a cover crop that is not highly competitive, not prone to shattering or lodging, not a tall growing crop and not a long season crop.

The most appropriate cover crop is a cereal grain sown at a reduced seeding rate, 15-20 kg/ha (13 - 18 lbs/acre) and harvested as an annual forage when it is at the dough stage of development. This very low seeding rate provides sufficient protection to prevent soil erosion without severe competition to the developing alfalfa. At harvest time the alfalfa will be nearly as tall as the cereal and will provide 4 to 5 t/ha (1.75 to 2.2 T/ac) of excellent quality feed.

If the cover crop is to be harvested as grain a seeding rate of one-third to one-half of normal can be used (eg. 0.75 to 1 bushel of wheat). Wheat and flax are the most commonly used cover crops, semi-dwarf wheats and polish type canola are gaining in popularity while barley and argentine canola are generally too competitive for best results.

With any cover crop it is important to minimize the time a swath covers the seedling alfalfa and to avoid heavy layers of chaff behind the combine. Direct combining or late swathing will eliminate or reduce the problem with a swath, while good spreaders or a chaff saver on the combine will prevent chaff build-up. For best results bale the straw and remove the bales from the field within two days after harvest.

Establishment

1) Fertilization

All fields should be soil tested prior to planting to determine the phosphorus, potassium and sulphur levels in the soil. If the field has been levelled, test the cut areas separately, as they will likely require heavier applications of phosphorus. Broadcast and incorporate the required amount of fertilizer prior to planting the alfalfa.

A deficiency of sulphur or potassium can be corrected in an established stand. The sulphate form of sulphur will move with the applied water. Irrigation waters generally supply enough sulphur to meet crop demands. Potassium is somewhat mobile. The near surface roots of the alfalfa will generally be able to use potassium during the season of application.

A general recommendation is to apply 120 kg/ha (100 lbs/acre) of P_2O_5 prior to planting. On sandy soils the addition of 50 kg/ha (45 lbs/acre) of K_2O is also recommended.

2) Seedbed Preparation

Since alfalfa is a small seeded crop the seedbed should be firm and free from clods or large amounts of trash. Some trash cover will reduce erosion and soil drying. Uniform seedbed preparation will result in uniform seeding depth and rapid emergence.

The tillage necessary for incorporation of preplant herbicide or fertilizer is often sufficient to prepare the soil. Over working tends to dry out the top 5 cm (2 in) of the soil which may result in reduced germination and increased erosion problems. Firm seedbeds can be established by following cultivation with either a rod-weeder, harrow packer, or press drill. Banding phosphorus fertilizer with a press drill prior to seeding the alfalfa is a commonly used and very effective method of providing a firm seedbed. An irrigation of 2 to 3 cm (.75 or 1.2 in) of water applied with a sprinkler system prior to seeding firms the surface layer of soil and provides enough moisture for rapid germination and emergence. In areas where few spring rains are expected or where pivot irrigation is not available the incorporation of chemicals and fertilizer in the fall is an option, but is only recommended if sufficient trash is left on the surface to prevent wind erosion during the winter and early spring.

3) Inoculation

Nitrogen fixing bacteria in association with alfalfa can convert nitrogen from the air into a form usable by the plant. Since the natural levels of these symbiotic bacteria in our soils is often low it is necessary to inoculate the alfalfa seed with a commercial mixture of the bacterium *Rhizobium meliloti*.

Purchase fresh inoculant (check expiry date stamped on the package) and store in a cool place until required. During seed inoculation, care should be taken that the inoculum powder, containing live bacteria, is not exposed to sunlight, high temperature or severe drying, as these conditions increase the death rate of rhizobia. For example leaving the inoculant on the seat or dash of a pick-up is a sure way to reduce its effectiveness.

The application of the inoculant to the seed as a dry powder or as water slurry, without the use of a "sticker" to bind it to the seed, is not effective. The following simple and effective procedures for seed inoculation are recommended.

1. Place the required amount of alfalfa seed in a pile (not more than 2 feet high) on a clean cement floor or in a tub away from direct sunlight. A cement mixer can be used if available.

2. Use either a soft drink, a sugar solution or skimmed milk as a sticking agent, sprinkle the solution evenly over the seed at a rate of one litre of sticker per bushel of seed. Let the liquid soak in and then mix the seed with a clean shovel.

3. Sprinkle the inoculant powder at the recommended rate over the sticky seed. Coat all seeds with inoculant by shovelling the seed and inoculant mixture back and forth until all seeds appear to be coated with the powder.

Seeding should be done shortly after inoculation, allowing only enough time for the seed to dry. Wet seeds may be damaged by the planter and may produce uneven seeding due to clumping. The inoculated seed should be protected from direct sunlight at all times and stored in a cool building.

Additional information on legume inoculation is available in Saskatchewan Agriculture's bulletin "Soil Improvement with Legumes".

4) Seeding

Seed irrigated forage alfalfa at 8 to 10 kg/ha (7 to 9 lb/ac) in rows approximately 15 cm (6") apart at a depth of 1 to 2 cm (.5 to .75"). This will result in approx-

imately 60-80 seeds per meter (20-25 seeds per foot). The best results can be obtained using a roller seeder (Brillion) or a press drill with forage seed attachment. A press drill can be used without the forage seed attachment, but the drill must be in very good working condition. The fluting in the seed cups must be in perfect alignment so that all seed runs provide an equal amount of seed.

Broadcast seeding is less satisfactory, but under good moisture conditions and with a slightly higher seeding rate reasonable results can be achieved. Broadcast seed must be harrowed in immediately behind the seeder to avoid sunlight killing the micro-organisms in the inoculant.

If a cover crop is used, seed the cover crop first then seed the alfalfa at an angle to the direction of travel used for the cover crop. This allows for the proper seeding depth for each crop and places the alfalfa outside the crop row thus reducing competition between the cover crop and the alfalfa.

5) Irrigation for Germination

The objective in irrigating seedling alfalfa is to maintain soil in the top 30 cm (1 foot) above 70% of field capacity. Excessive irrigation at this time may wash out the seeds or seedlings or cause water erosion pathways on the field which will result in runoff problems throughout the life of the alfalfa stand.

One irrigation of 2 to 3 cm (.75 to 1.2 in) two or three days prior to seeding followed by frequent light irrigations after germination will promote vigorous growth in the alfalfa seedling. After the stand is well established, approximately six weeks after seeding, irrigate to maintain the top 60 cm (2 feet) of soil above 50% of field capacity.

Those growers whose irrigation systems are just being installed would be advised to delay seeding until the system is operating satisfactorily.

6) Weed Control in Seedling Alfalfa

Weed control should begin at least one year prior to planting alfalfa. Perennial weeds such as quack grass, Canada thistle, sow thistle, and dandelion should be eliminated from the field if at all possible.

Your choice of a cover crop may depend on the type of weeds common in the preceeding crop, e.g. if flixweed or stinkweed are a problem use a cereal and spray with 2,4-DB. If wild oats are a problem avoid using oats as a cover crop, or cut it for feed.

Twelve herbicides are listed in the 1987 guide to Chemical Weed Control on Cereal, Oilseeds, Pulse, and Forage Crops for seedling or established alfalfa. Many of these are restricted to seed alfalfa or alfalfa in the establishment year when the straw is not used for feeding. Refer to this publication for details.

Chemical Weed Control in Cereal, Oilseed, Pulse and Forage Crops 1987

One of the most effective control measures for annual weeds is to cut the field for forage before the weeds mature. Good weed control in the establishment year and good management practices should keep weed problems to a minimum for five or six years. The cost of effective herbicides may make it more economical to plow down weedy fields.

Stand Maintenance and Production

1) Fertility

Alfalfa uses large amounts of plant nutrients (Table 1) and high yields will not be possible if any of these nutrients are lacking.

Table 1: Plant Nutrients Used By Crops

		Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Sulphur (S)
Wheat	Seed	60	24	16	4
2690 kg/ha	Straw	25	5	48	6
40 bu/acre	Total	85	29	64	10
Alfalfa		240	40	190	20

9.0 tonnes/ha
4 tons/acre dry matter

Source: Western Canada Fertilizer Association

Most of the nitrogen needs of alfalfa are met by the fixation of atmospheric nitrogen, if the alfalfa is properly nodulated.

The majority of Saskatchewan soils are deficient in plant available phosphorus and yearly broadcast application of 60 kg/ha (53 lb/ac) P_2O_5 are recommended for maximum yield. Since it takes one full season for surface applied phosphorus to leach into the root zone and become available to the crop, the timing of application is not critical. To spread out the farm work load, many growers apply phosphorus fertilizer just after the first or second cut.

Drilling or banding fertilizer into an established crop should be avoided. The mechanical damage to the alfalfa will cause yield reduction for at least one year and under some conditions the field will never fully recover.

Generally, Saskatchewan soils have adequate levels of potassium. Exceptions are coarse textured soils with low clay content and the grey soils in the northeast part of the province. Soil testing less than 270 kg/ha (249 lb/ac) in the top 15 cm (6 in) should receive yearly applications of potassium up to 100 kg/ha (89 lb/ac).

Sulphur needs are usually met through dissolved sulphate in the irrigation water. In cases where the land was not previously irrigated, additional sulphur may be recommended.

To ensure maximum production, fertility levels should be monitored throughout the life of the stand by soil and tissue analysis.

Plant tissue analysis provides information on the fertility status of established alfalfa and combined with soil analysis will be of assistance in designing a fertility package. For optimum production alfalfa plants at bud-stage should contain approximately **3% nitrogen, 2% potassium, 0.2% phosphorus and 0.2% sulphur.**

When collecting samples for plant tissue analysis follow a procedure similar to taking soil samples.

- Samples should be taken at the bud stage of development.
- Randomly select 25 to 30 representative plants and collect the top 1/3 of each.
- Brush off any dust and dirt on the sample but do not wash.
- Allow the sample to dry at normal room temperature.
- Place in a paper bag (sample bags are available from the Saskatchewan Soil Testing Lab).
- Provide details of the field (similar to information on soil test form).
- Place in a shipping box and mail or deliver the sample to:

  Saskatchewan Soil Testing Laboratory
  General Purpose Building
  University of Saskatchewan
  Saskatoon, Saskatchewan
  S7N 0W0

Avoid contamination of the sample with soil, do not heat to dry and do not place in a plastic bag.

2) Irrigation

Alfalfa responds very well to irrigation. Under normal Saskatchewan conditions each additional centimeter of irrigation water will increase yield by 135 to 175 kg/ha (300 to 500 lb/ac/in). Poor fertility, weed competition, thin stand, disease, or insect pests will reduce the yield response.

Irrigation scheduling for a forage crop is more straight forward than for a grain crop. Moisture stress at any stage of growth will reduce yield but no single growth stage has been identified as being more susceptible or more tolerant than another. There is a direct relationship between **water use** and **alfalfa forage yields** as illustrated in figure 1.

When a multi-cut harvest is planned, adequate moisture must be available to the plant early in the spring and immediately after each cut, to promote and maintain rapid growth.

The scheduling of irrigation for alfalfa production is dependent on the following three factors:

- the water holding capacity of the soil;
- daily crop water use; and
- the time required to apply one irrigation to the field.

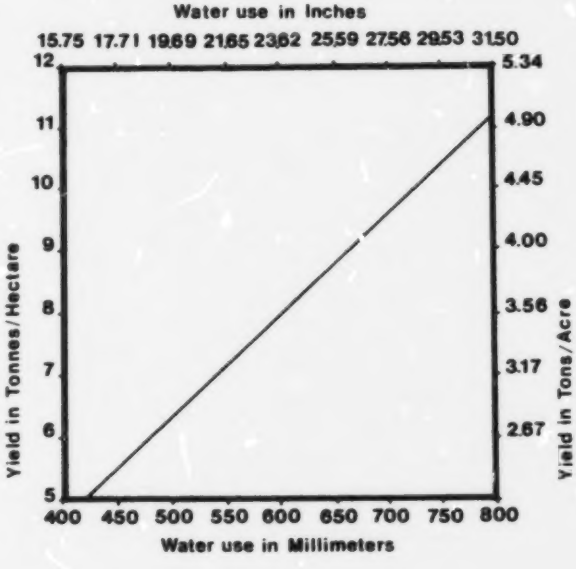


Figure 1: Water Use vs Alfalfa Yield

adapted from
Hobbs, E.H.; Krogman, K.K. and Sonmer, L.G., 1963

i) Water Holding Capacity of Soil

Soil texture refers to the relative proportion of sand, silt and clay size particles in a given soil. It influences the rate at which water infiltrates the soil, the amount of moisture it can hold and the natural fertility and nutrient supplying ability of the soil.

Water holding capacity is an expression of the soil's ability to hold water and is related to the soil structure or arrangement of soil particles into aggregates and the soil texture. Generally, coarse textured soils have lower water holding capacity than finer textures.

Water is held between and on soil particles. Soil moisture available to plants is within a range known as available moisture or between moisture held at field capacity. (1/3 atmosphere tension) and permanent wilting point (15 atmospheres tension).

The moisture held at lower tension is the most easily used by the plant and is termed **readily available moisture.** As can be seen in Table 3 available moisture increases as soil textures become finer.

Table 3: Soil Water Holding Capacity

Texture		Approximate Available moisture in millimeters/meter (inches/foot)		Readily available moisture in millimeters/meter (inches/foot)	
Loamy Sand	LS	85	(1.00")	60	(0.75")
Sandy Loam	SI	120	(1.40")	60	(0.75")
Loam	L	170	(2.00")	85	(1.00")
Clay Loam	CL	195	(2.00")	85	(1.00")
Clay	C	210	(2.50")	85	(1.00")

ii) Daily Crop Water Use

The amount of water used by a crop depends on the volume of foliage, air temperature, relative humidity, wind speed, availability of water and, to some degree, the available nutrients and sunlight intensity. Figure 2 shows the approximate daily use of a good stand of alfalfa from May 1st until October 1st.

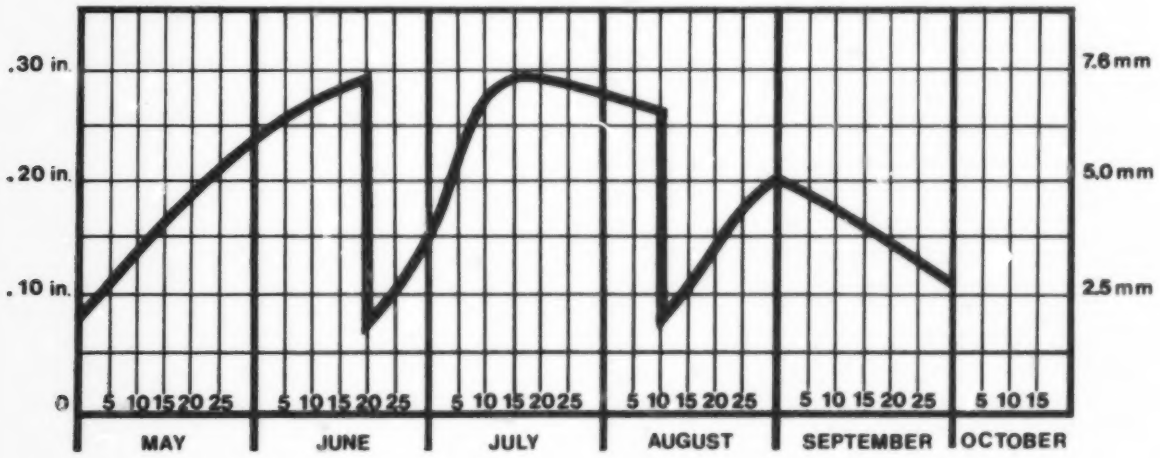


Figure 2: Type of Water Use Curve Expected With Alfalfa When Cutting Is Considered

Alfalfa up to 30 cm (12 in) tall will average about 3 mm (0.12 in) of water use per day, given adequate soil moisture. From 30 cm in height until first bloom the same crop will average close to 6 mm (0.24 cm) per day. Hot, dry weather will increase this amount while cool, moist conditions will result in lower water use. Maximum daily water use may exceed 8 mm (0.31 in).

This adds up to approximately 230 mm (9.0 in) for the first cut and because of hotter weather, 280 mm (11 in) for second cut. An additional 150 mm (5.9 in) will be used for regrowth after the second cut, giving a total yearly consumptive use of 660 mm or 26 inches.

The above figures will be fairly accurate for the brown soil zone but water use will be 10 to 20% lower for the dark brown and black soil zones.

iii) Irrigation Scheduling for Sideroll Flood

The following are examples of how the information presented below is used to determine the irrigation intervals for wheelmove or flood systems.

To obtain the maximum interval multiply the readily available moisture per meter by the depth of wet soil in meters, and divide by the daily water use.

Example: Loam $\frac{85 \text{ mm} \times 1 \text{ m}}{6 \text{ mm/day}} = 14 \text{ days}$

** Check moisture depth with a soil probe. If moisture penetration is less than 1 m maximum irrigation intervals will be reduced.

To obtain maximum alfalfa production the readily available water figure is used, not the total available water. This example shows that the heavier soils provide moisture for approximately four more days during peak water use periods than do light soils. Each irrigation should add 60 to 100 mm (2.5 to 4 in) of water to the soil.

Flood irrigation is not recommended for light textured soils. Wheelmove irrigation can be used on all soil textures with the irrigation intervals ranging from 10 days on light soils to a maximum of 14 days on heavier soils during the peak water use period.

Table 4: The Effect of Soil Texture on Irrigation Interval

Soil Type	Readily Available Moisture/meter	Wetted Root Zone	Crop Consumptive Use	Maximum Irrigation Interval
Clay	85 mm (3.4")	1 meter (3.28')	6 mm (.24")/day	14 days
Loam	85 mm (3.4")	1 meter (3.28')	6 mm (.24")/day	14 days
Loamy Sand	60 mm (2.4")	1 meter (3.28')	6 mm (.24")/day	10 days

In the south west part of Saskatchewan the first irrigation is usually in early May, in the north and central areas late May or early June. The first cut is mid to late June. With luck the crop is off the field by July 1st and the field is immediately irrigated. A third irrigation is given approximately three weeks later. This is usually sufficient to maintain soil moisture until after the second cut.

If three cuts are intended a fourth irrigation is applied as soon as the second cut is removed. If only two cuts are planned delay the fourth irrigation for two to three weeks. In some years a fifth irrigation, late in the season may be needed to provide sufficient moisture for early spring growth. Irrigation in late September or October may reduce winter hardiness of the alfalfa and should be avoided.

When using a wheelmove system careful planning is required to time the harvest and irrigation operation. Fields may have to be split and sequentially harvested, so there is never more than three weeks between irrigations.

iv) Irrigation Scheduling with A Center Privot

With pivot irrigators, management becomes a little more complicated. The irrigation system must be shut down for a few days prior to cutting to let the field dry and firm up, to reduce damage due to compaction and wheel tracks.

If the system is shut off five days before beginning the harvest and it takes 10 days to cut, cure, bale and remove the bales, there is a 15 day period without irrigation. During this period the crop can use up to 70 mm of water (2.8 in). By the time the pivot is running, daily crop use is 3.5 mm (0.14 in) and climbing. The average system has a net applicaton rate of 5.6 mm (0.22 in) per day. Crop water use will reach this level about two weeks after cutting, or five days after the system started up. During this five day period the pivot will put on enough water to meet crop needs and store about 20 mm (0.4 in) of moisture in the soil. The system will roughly hold its own for the next week to 10 days, by which time the crop use will be greater than the application and the crop will draw on soil moisture reserves.

As you can see by the above example, if you can reduce the time the system is shut off for harvest by even one or two days, you can reduce the risk of drought stress significantly.

Alfalfa producers in the warmer areas of Saskatchewan should consider purchasing a system with a larger pumping capacity, thus reducing the difference between daily water use and daily application rate. An application rate of 6.6 mm (0.26 in) per day would reduce the risk of yield loss due to inadequate water. This amounts to an additional 150 U.S. gpm on a standard quarter section pivot.

Due to their longer period of active growth and ability to produce multiple crops when properly irrigated, perennial forages have a higher annual consumptive use than grain crops. Average daily consumptive use is usually lower because as soon as the crop reaches full vegetative growth it is cut.

3) Fall Management

Fall management of an established alfalfa field is primarily directed toward increasing winter survival and vigor.

If a third cut it taken, cut a minimum of 10 cm (4 in) of stubble and leave an uncut strip on every round. This provides a snow trap that insulates the alfalfa from low temperatures and provides extra moisture in the spring. Snow trapping is particularly important with some less winter hardy varieties but will benefit all varieties.

Fall irrigation to wet the top 1 m (3.3 ft) will provide enough moisture to get the crop off to a good start in the spring and the grower will be able to delay irrigation until spring work is completed. In dry years fall irrigation or early spring irrigation can double first cut yields. Heavy irrigation in late September or October can reduce winter hardiness; therefore, fall irrigation should be applied before mid-September.

The last cut of the year should be either 4 to 6 weeks prior to a killing frost or after soil temperatures drop below 10 degrees C, usually early October. Regrowth after cutting depletes root reserves and weakens the plant. If the plant goes into winter with low root reserves the danger of winter injury is increased. Alfalfa needs about 5 weeks of growth after cutting to replenish these root reserves. Alfalfa cut when soil temperature is below 10 degrees C will not regrow, therefore will not deplete the root reserves.

4) When to Break

When should you break-up an existing stand of alfalfa?

Finding an answer to that question is probably the most difficult management decision to be made by an alfalfa producer. The following two-step procedure should assist you in making the right choice.

Firstly, consider the importance of the present alfalfa crop to the total farm enterprise:

- Is the main reason for growing alfalfa for feed or as a legume rotation?
- Have you an alternate feed supply or a newly established alfalfa field to replace the breaking?
- How does breaking the alfalfa affect your cash flow?
- Is the expected dollar return higher or lower from your existing alfalfa than from a similar field in grain?
- Are you irrigating on a Federal or Provincial forage project or on your own land?

Secondly, consider the current condition of the alfalfa field:

- Has the yield declined to less than three quarters of the peak production?
- Are weeds beginning to reduce yields and hay quality?
- Has the proportion of grass vs alfalfa increased to a point where yield and quality are reduced?
- Is the cost of breaking and reseeding justified based on the above yield and quality deterioration?
- How successful have you been in establishing new alfalfa fields?

To break or not to break is an individual decision, based on many factors. A grower who intensively managed alfalfa as a cash crop in rotation with cereal and oilseed grains will likely break-up the field in three to five years, regardless of its condition. A cattleman with no alternate stable feed supply may maintain a field for as long as its still reasonably productive. Both may be doing what's right for them.

A general recommendation is to break-up the alfalfa field when yields decline to less than 75% of the top yield from previous years, or when the growth of grass or weeds decreases the forage quality to the point where feeding or marketing problems become significant.

Harvest Management

1) Harvest Objective

The objective when harvesting alfalfa hay is to harvest the maximum yield of high quality forage. High quality, high protein alfalfa hay is readily marketable and should be considered as a feed concentrate, a source of protein similar to other protein supplements such as canola or soybean meal. If cut at the late bud stage, and processed properly, alfalfa can be used to supplement lower quality feed such as slough hay or straw. As a concentrate alfalfa is far more valuable to a producer on a per ton and a per acre basis.

The key to producing good quality alfalfa hay under irrigated conditions is to treat the crop as you would a special cash crop rather than like the grass growing along a highway.

2) Stage of Cutting

To obtain the maximum yield of good quality high protein feed, cut alfalfa at the late bud stage. There is very little yield increase after 10% bloom while protein and energy content drop significantly (Figure 3).

What are the implications of cutting a full bloom versus full bud? For example, compare the number of brood cows that could be supplied with winter feed from one acre of irrigated alfalfa cut at the late bud stage as opposed to the full bloom stage. Research has determined that although alfalfa cut at the full bloom stage produces six percent more yield than alfalfa cut at the full bud stage, the protein percentage of the forage drops by approximately one third from the 22-23% range to the 15-16% range. The percentage of Total Digestible Nutrients (TDN) can drop anywhere from 10% to 20% or from the 60% TDN range to the 50% TDN range.

If two cuts of alfalfa cut at the full bloom stage yield 3.6 tonnes (4 tons) per acre per year of 15% protein and 50% TDN alfalfa hay, the same field cut twice at the full bud stage would yield 3.4 tonnes (3.76 tons) of 22% protein, 60% TDN alfalfa hay. Assuming that the daily requirements of a brood cow is 9 kg. (20 lbs.) of 50% TDN forage then the 3.6 tonnes (4 tons) of 50% TDN alfalfa hay would feed 2.35 cows per winter based on a 170 day feeding period. The same acre of alfalfa cut at full bud stage at 60% TDN would produce enough quality to be mixed one to one with 40% TDN cereal straw to produce 50% TDN ratio.

The 3.4 tonnes (3.76 tons) of hay fed as a concentrate at 4.5 kg. (10 lbs.) per cow per day along with 4.5 kg. (10 lbs.) of cereal straw would feed 4.4 cows per winter based on the 170 day feeding period.

Alfalfa cut at the full bud stage versus the full bloom stage will produce enough high quality forage to feed almost double, 4.4 versus 2.35, the number of cows per acre per winter, assuming that straw is available for substitution. Farmers can not afford to produce poor quality alfalfa hay.

Also by leaving the alfalfa to full bloom the water use efficiency is greatly reduced. The time from late bud to full bloom is about ten to fourteen days. Water use is at maximum levels during this period and may amount to 100 mm (3.9 in) or more. The added yield, as outlined in the previous example, is only about 6% while the extra water use is over 30%. If water is in short supply and if this water could be saved for the next cut you could expect an additional return of one tonne per per hectare. If water availability is no problem you are still saving $25.00 to $37.00 per hectare ($10.00 to $15.00 per acre) pumping costs.

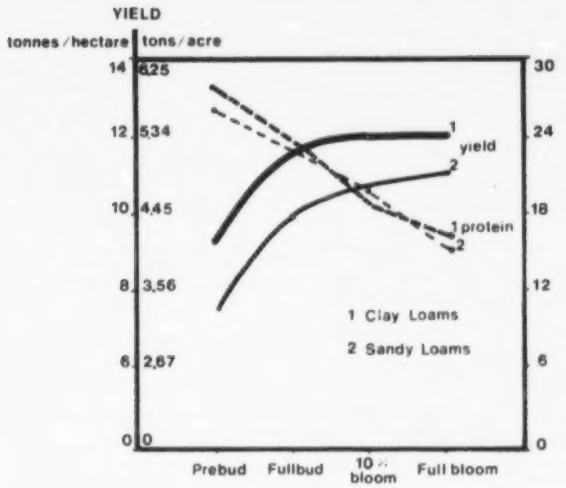


Figure 3: Forage Yield and Protein Content of Alfalfa at Different Growth Stages (Bailey 1984)

When irrigation is available growers are able to harvest more than once per year. Two cuts, one in late June and one in early August, are commonly taken under irrigation. Growers wishing to push the crop a little harder will use rapid regrowth varieties and take three cuts per year. The first two cuts are taken at the late bud stage, about June 15th and July 25th. The third cut is taken after a killing frost (-3° C) or early October, by which time root reserves have been built up for the next year's spring growth and soil temperatures are cool enough to minimize late fall regrowth. Growers should be aware that such an intensive production schedule may reduce the longevity of an alfalfa stand to three or four productive years. A common practice is to take three cuts one year and two the next year.

Delaying cutting to over 25% bloom will mean the second cut is not taken until mid-August, and regrowth will not be sufficient to warrant a third cut.

3) Harvesting Tips

Successful alfalfa production depends on many factors but none are more important that the procedures used for harvesting. Listed below are some harvesting practices suggested by successful growers.

- Avoid cutting hay until the dew from the previous night has evaporated;
- Leave approximately 8 cm (3 in) of stubble to allow for air flow under the cut hay;
- Never cut more in one day than you can bale in one day. This procedure avoids the risk of having more hay ready at any given day than you are capable of baling, thus exposing that hay to a greater risk of rain damage;
- If you must turn the hay due to wet weather do so only in the early morning when the hay is damp with dew and leaf loss will be low. Only turn the amount that you can bale that day, avoid turning the hay more than once should bad weather return again;
- The baling operation should be geared to avoid leaf loss. The leaves of alfalfa contain 60% of the plants nutritional value. They also contain 70% of the protein and 90% of the vitamins. To avoid leaf loss you must avoid baling during the heat. The expressions **"Make Hay While The Sun Shines"** might have applied for slough or crested wheat grass hay but it surely does not apply to alfalfa hay. The expression **"Make Hay on Nights After The Sun Shines"** would be more appropriate. Hay that is too dry will shatter during baling. The moisture content of baled hay should be less than 30% for safe storage. Baling in the late morning, after the previous night's dew has evaporated and before the hay becomes too dry, or baling in the evening when the hay begins to take on night moisture, are the two best times to bale to reduce leaf loss.
- Baling will have to stop at night when dew forms. This often occurs around 3:00 a.m. At this point you will notice your tractor tires become shiny from moisture, the hay will tend to hold up on the pickup a little before going into the baler and if you are running a square baler you will start to hear it pound. Be careful with round balers as they work well in damp conditions and you might be fooled into baling hay which will not store.
- Finally, remove the bales as soon as possible so that you can irrigate the stand to provide for the next cut or for fall regrowth and to prevent dead spots from smothered plants.

4) Machinery requirements

Machinery investment for hay production is often significantly higher than for cereal and oilseed crops. Care should be taken not to over-invest in haying equipment, but you must have haying equipment that is in good running order and of sufficient capacity to quickly remove the hay from the field. If you are investing in both new irrigation development and a complete line of haying equipment, you might consider reducing your investment by purchasing good second-hand haying equipment. If you are purchasing equipment, emphasis should be placed on a good baler as this machine is the one that you can least afford to have problems with.

The cutting operation can be done a number of ways: a mower and rake, a mower conditioner, a self-propelled swather or an SP swather with a conditioner attachment.

For a small operation, less than 20 hectares (50 acres) perhaps the mower-rake combination or a SP swather with a 5 m (16 ft) grain table could be used. Operations in the 20-60 hectares (50-150 acres) range should consider adding a conditioner to an SP swather whereas operations which exceed 60 hectares (150 acres) should consider purchasing a forage header-conditioner for the SP swather or a pull-type mower conditioner.

Grain swathers are not built strong enough to work well in heavy forage crops. Canvas and knife drives tend to cause problems and without pick-up reels the grain swather can not cut as clean or evenly as can a forage header.

The following example should provide a guideline for equipment requirements for various sized operations:

Area	0 - 20 ha. (0 - 50 ac.)	20 - 60 ha. (50 - 150 ac.)	60 ha. & Over (150 ac.)
Cutting	small haybine	4 - 4.5 m (12 - 14 ft.) SP swather c/w conditioner	4 - 4.5 m (12 - 14 ft.) SP Swather c/w forage header or 4 - 4.5 m (12 - 14 ft) mower conditioner
	SP swather		
Baling			
Small sq. bales	small-medium capacity baler	large capacity baler	* maximum acreage for large capacity baler
Round bales	small or large round baler	large round baler	* maximum acreage for large round baler
Hauling			
Small sq. bales	bale stooker or small pull-type stack wagon	medium to large pull-type stack wagon	*larger pull-type stack wagon
Round bales	small round - 50 hp tractor with loader	—	—
	large round - 70 hp tractor with loader	90 hp tractor with loader	90 hp tractor with loader or automatic bale wagon

* Maximum area of 60 hectares is relative to time available to bale, haul and avoid weather delays. Teaming up with neighbors for baling and/or hauling can reduce investment substantially.

Trouble Shooting

Problem	Possible Cause	Possible Solution
Wilting	— Drought	Irrigation.
	— Verticillium wilt	Take representative plant to Ag. Rep. for disease diagnosis. If verticillium is confirmed, plow down.
	— Root rot	
	— Frost	
Poor yield	— Weed competition	Cut early on first and second cut.
	— Lack of irrigation	Keep moisture and fertility high.
	— Fertility	Tissue test to determine status.
	— Age of stand	Production will drop after 5th year. Break and seed to grain crop for at least 3 years.
Yellowing	— Lack of nitrogen	Do a better job of inoculation next time.
	— Disease or insects	Take representative sample for diagnosis.
Low plant population	— Winter kill Poor establishment	May require replanting
Slow regrowth after cutting	— Lack of water	Irrigate.
	— Lack of fertility	Take soil and tissue samples for analysis and fertilize.
Winter kill	— Cutting during critical time, Aug. 20th - Oct. 1st	Break and seed to grain crop for 3 years before reseeding to alfalfa.
	— moisture stress during critical time	Ensure that the alfalfa stand has adequate moisture and is not cut during the period August 20th to October 1st or the first killing frost.
	— Low potassium levels	Add 0-0-60 fertilizer after first cut each year.
Alfalfa blooming earlier than expected	— Drought	Ensure adequate irrigation during growing period.
June frost stops alfalfa growth	— Frost	Cut immediately if the top 1/3 of plant is damaged for rapid regrowth and an improved second cut
Grass encroaching	— Fertility (high nitrogen, low phoshorus)	Increase phospate levels.
	— Cutting schedule late	Cut earlier.
	— Old stand	Re-plant.
Poor establishment	— Seeding too deep	Seed 1 to 2 cm (.5 to .75 in).
	— Crusting	Seed cover crop. Irrigate more frequently.
	— Poor germination	Use good seed

Summary

- To grow a successful crop of alfalfa, start preparation at least one year ahead of seeding by choosing a field without major weed problems and free from herbicide residue.
- In the year of seeding apply 120 kg/ha of P_2O_5 (100 lb/ac) and if necessary 50 kg/ha K_2O (45 lb/ac).
- Work the soil enough to form a fine firm seedbed and seed well inoculated seed at 10 kg/ha (9 lb/ac)
- Use a cover crop if necessary, but at a lower than normal seeding rate.
- Irrigate 300 to 400 mm (12 - 16 in) in year one.
- If no cover crop has been seeded, cut once in July.
- If using a cover crop, minimize the period of time between swathing and harvest and bale off the straw.
- On established fields apply yearly application to 60 kg/ha (53 lb/ac) phosphorus and if necessary a similar amount of potassium.
- Begin irrigation early in the spring unless it was fall irrigated.
- Irrigate 400 to 600 mm (16 - 24 in).
- Cut at the first sign of bloom for the first and second cut.
- If the growth is vigorous take a third cut in October leaving higher stubble and snow catch strips, remove the swath and bales as quickly as possible.
- The most important point to remember, when irrigating alfalfa, is that during the first stage, cutting to 30 cm (12 in) regrowth, alfalfa requires about 3 mm of water per day. In the next stage, 30 cm to cutting, the alfalfa plant demands an average of 6 mm per day to provide for maximum growth.

Resource Personnel:

Saskatchewan Agriculture staff at district and regional offices.

Agrologists with the Saskatchewan Water Corporation

Agriculture Canada Research Scientists.

Saskatchewan Irrigation Development Centre.

Publications:

Agriculture Canada
- Growing and Managing Alfalfa in Canada

Saskatchewan Agriculture
- Chemical Weed Control in Cereal, Oilseed, Pulse and Forage Crops.
- Soil Improvement with Legumes.
- Forage Manual.